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SEATTLE DEPT OF PSYCHOLOGY E HUNT OCT 83 TR-83-1
N00014-80-C-0631

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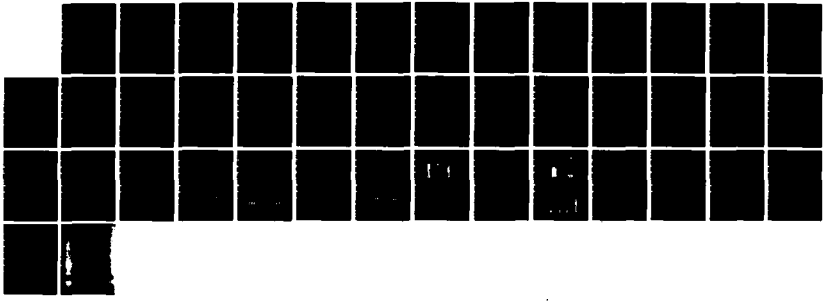

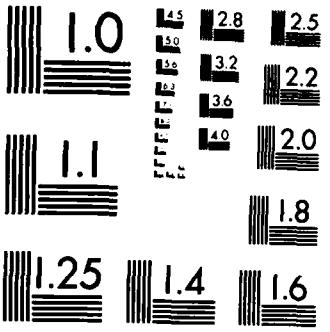

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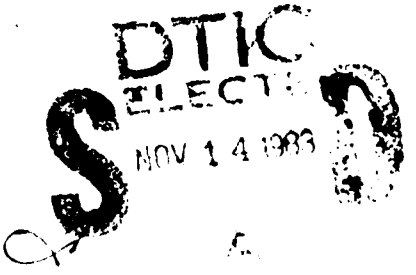
The Next Word on Verbal ~~Activity~~ Ability

Earl Hunt

October 1983

This research was sponsored by:

Personnel and Training Research Programs
Psychological Sciences Division
Office of Naval Research
Under Contract No. N00014-80-C-0631
Contract Authority Identification Number, NR 150-457



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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 83-1	2. GOVT ACCESSION NO. AD-A131 643	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* THE NEXT WORD ON VERBAL ABILITY		5. TYPE OF REPORT & PERIOD COVERED Technical Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Earl Hunt		8. CONTRACT OR GRANT NUMBER(s) N00014-80-C-0631
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Psychology University of Washington Seattle, WA 98195		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 150-457
11. CONTROLLING OFFICE NAME AND ADDRESS Personnel and Training Research Programs Office of Naval Research (code 442PT) Arlington, VA 22217		12. REPORT DATE October 1983
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Paper presented at A.E.R.A meetings, Montreal, Canada, April 1983.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Individual differences, verbal ability, reading, intelligence, comprehension.

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The recent literature on individual differences in verbal ability is reviewed. People who demonstrate generally high verbal comprehension are quicker and more accurate in identifying lexical items, and are more rapid in parsing sentences. They are not more sensitive to the general gist of a passage, and thus do not respond to priming from context more than do people of lesser verbal ability. The picture that emerges is that the person with good verbal ability is more aware of precisely what the linguistic message is, and how

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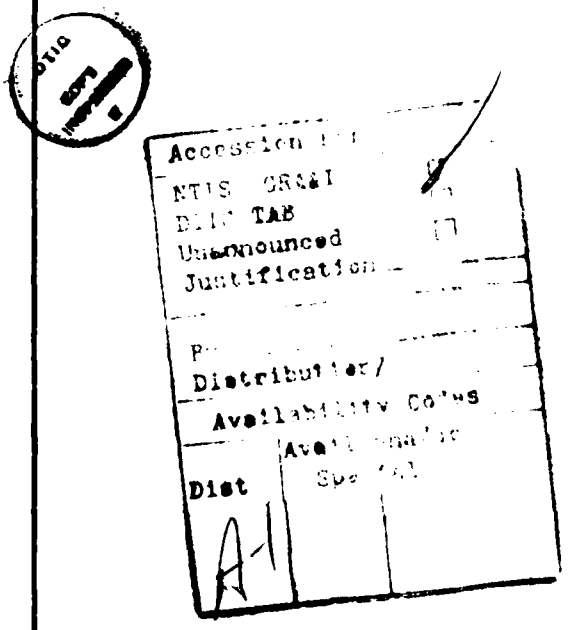
it can be manipulated independent of context. Thus the verbally competent person is better able to respond to the meaning of the message itself, and does not need to depend upon contextual cues to the extent that the less verbally competent person does.



The Next Word on Verbal Ability (1)

Earl Hunt

The University of Washington

The ability to make sense out of verbal communication is perhaps the most important learned behavior that there is. People are amazingly adept at finding meaning in messages. At a recent press conference the President of the United States used the term "Christmas tree" as a transitive verb, and his audience understood him. Unfortunately, there is another side to the coin. Odysseus observed that not all men have the gift of eloquence, every classroom teacher has observed that not all have the gift of comprehension. Traditionally, identifying those who did-or didn't-have verbal ability was regarded as a problem in classification, and an impressive set of tests was developed to identify the verbally proficient. Since about 1970 experimental psychologists began to be interested in explaining how individual differences in verbal ability arose from individual differences in the execution of processes that might underlie verbal ability. In this paper I review the gist of their findings. Although I am not an educator, I shall speculate on the meaning of these findings for education.

Historically, verbal aptitude has played an important part in our definitions of intelligence and academic aptitude. Tests of various aspects of verbal behavior are routinely used

in academic aptitude batteries. Table 1 lists an example, the battery used for college selection in the State of Washington. It contains three unarguably verbal tests; vocabulary, paragraph comprehension, and grammatical knowledge; some clearly non-verbal tests (e.g. spatial reasoning), and one test, arithmetical problem solving, that contains both verbal and non-verbal components. Table 2 presents the results of a factor analysis that was computed using data obtained from college students who had taken the tests shown in Table 1. Three factors emerged. The first was a clearly a dimension of ability associated with the verbal tests. Note in particuar the high loading of the vocabulary test upon the verbal factor. This will be important subsequently.

Is verbal ability important outside of the test taking environment? The students in our study were given tests of subject-matter knowledge, in addition to the aptitude tests. Table 3 shows the results. People with high verbal aptitude tend to know more facts. This is true even though the tests themselves are designed to require only common knowledge. The extent of the relation varies with the field of knowledge being tested.

This result is not a vagary of the highly verbal academic world. Studies similar to ours have been carried out in quite a different world, the U.S. Army. Table 4 shows the correlation

between tests of reading and listening and field tests of performance in various military occupations (Stieht et. al. 1981). The tests were among the best predictors of success in such non-academic fields as motor vehicle repairman or armored vehicle crewman.

Tables 1,2,3,4 here

What does the psychometric data tell us? First, that there is dimension of individual differences called "verbal ability." Second, that verbal ability is related to success in a variety of fields. The correlations are not startingly high, but they are about as high as any other predictors of success that we have been able to find. Furthermore, they are very general. Verbal ability contributes something to success almost everywhere. Finally, verbal ability is very well measured by giving people vocabulary tests. This is an encouraging finding. Vocabulary tests are easy to give, so determining a person's verbal ability should be cheap. Vocabularies are obviously acquired, so if word knowledge is the key to verbal ability, then an important part of intelligence is trainable.

There is some truth to this happy conclusion, but it is

not the whole story. The conclusion follows from the (implicit) assumption that verbal ability is defined by test taking behavior. As is well known a position was taken by Professor Boring (1923). My own approach is not in the Boring tradition. I do not believe that this is a defusible position, for reasons that I have explained elsewhere. (Hunt, 1983). A reasonable alternative is to say that individuals differ in their verbal ability, an abstract entity, and that the various tests are statistical indicators of who has verbal ability but not defining indicators of the ability itself. To understand what verbal ability is, one must consider how the comprehension process takes place and how individual differences may impose themselves on it. The remainder of the paper is devoted to such an analysis.

Three themes will recur throughout the paper. The first is that the task of comprehension can be broken down into several component processes. (See Sternberg (1980) for a good discussion of the implications of this fairly obvious notion.) In verbal comprehension the component processes must be executed simultaneously. For instance, a listener must be able to recognize the word that is being spoken while parsing the phrases that have just been spoken, and relating their meaning to the meaning of utterances received minutes, hours, or days previously. Because several operations must be executed in parallel, the comprehender faces a substantial problem in

attention allocation. This raises a second theme, that the subprocesses of comprehension compete for information handling resources. Specifying just what these resources are would require a theory of attention. In the absence of such a theory, the resources needed to comprehend will be treated collectively, as "attentional resources." This is admittedly a primitive notion, but it is one that can be used to order a variety of phenomena (Kahneman, 1973).

The third theme may seem trite, but it is the most important of the three. The purpose of comprehension is to understand. A comprehender will allocate attentional resources until meaning has been extracted. The search for meaning, though, need not be limited to a strict linguistic analysis. Indeed, if meaning can only achieved by overriding precisely what was said, then the precise analysis will be ignored. This is illustrated by the following example, taken from a commercial birthday card. The card contained a picture of a 1930s Chicago mafioso, and the legend

1) Unexcavated as I am at making flowery electrocutions, the cerebration of your birthday perspires me to deliver this brief but heartfelt massage:

Conflagarations and many happy reforms!

In one sense, these sentences have no meaning at all. The meanings of the individual words just do not fit. In order to understand example 1 the reader must override accurate lexical access. Once this is done a common "formulaic statement" is apparent, Happy Birthday! There is a fine balance here. Completely accurate lexical analysis does not produce meaning. On the other hand, if a reader "unconsciously" substitutes words for their near homonyms, as in "unaccustomed" for "unexcavated", or (better) "eloqutions" for "electrocutions", the message becomes sensible but trite. Mrs. Malaprop did not know she was being funny! The humor of the message is apparent only if the comprehender realizes that sentence parsing can be achieved only after incorrect lexical access.

When meaning is the goal, any way of achieving meaning is legitimate. In particular, specialized vocabularies and extra-linguistic knowledge of the situation can be used..if the comprehender is aware of them. The point is illustrated by the following example. It is meaningful to a huddle of experts.

2) We'll stop the safety blitz. Tight end cut out.

Example 2 cannot be understood at all without knowledge of the vocabulary of American football. Given this, and knowledge of

permitted ellipses in English syntax, one can predict that a certain player will run toward the sidelines on the next play. By combining the linguistic analysis with knowledge of what a safety blitz is, and ways to stop it, one can further predict that there will be a forward pass, although the pass is not mentioned in 2. The tight end, often not a high verbal, would be expected to make the inference

Figure 1 is an attempt to develop the argument more formally. Language is intended to communicate. A comprehender must construct a representation of the external world inside his or her own head, by analyzing the messages received from the outside. Some of these messages are linguistic, and require explicitly linguistic analysis. These can be classified, loosely, as lexical processes, involving single words, and syntactical-semantic processes involving groups of words. Lexical and syntactical-semantic processing are necessary for message understanding, but they are seldom sufficient. Pragmatic analysis of the message in the context in which it occurs is virtually always required.

The comprehender meets the demands of the communication situation by allocating resources to processes in each of the three classes. This is necessary because the processes are concurrent; speech is continuous over time. The lexical and syntactic processing of new input must compete for resources

with the syntactical, semantic, and pragmatic processing of old input. In addition, the processing of new input will be guided by the results of analysis of previous speech fragments. Individual processes will vary greatly in the amount of resources they require, and in the quality of their final output. To what extent do people differ in the quality of output of various processes, and in their ability to direct resources to different components of comprehension as those components become critical? These are the questions we must answer if we are going to understand verbal ability instead of simply assessing it.

Figure 1 here

LEXICAL PROCESSES

Comprehension begins with the identification of words and retrieval of their meaning. The processes involved may deal either with word elements (speech sounds, letters, or letter features) or with whole words. The term "lexical processing" will be used to refer to all aspects of comprehension at or

below the word level.

There are substantial individual differences in lexical processing, even below the level of word identification. In an early study in our own laboratory, (Hunt, Lunneborg, and Lewis, 1975) college students were asked to judge the sequence of dichotically presented sounds. The experimental situation is shown diagramatically in Figure 2(a). Figure 2(b) plots the results, showing accuracy of discrimination type of sound; either a phoneme (/bae/,/dae/ or /gae/ or a non-speech sound (buzz, hiss, tone), and as a function of performance on a written test of verbal ability. Clearly the high verbal students were better at hearing speech sounds, but were not better at acoustic temporal judgement tasks in general.

Figure 2 Here.

Frederiksen (1982) has reported a somewhat analagous study using visual speech stimuli. High school students were shown strings of letters followed by a visual mask. A possible sequence would be

3) tmea

eeee.

The time between the onset of the letter string and the mask (stimulus onset asynchrony-SOA) was varied systematically. Frederiksen estimated the rate of extraction of visual information from the stimulus by analyzing the improvement in report as SOA increase. (A rather complicated procedure was used to do this. No attempt will be made to explain it here.) Table 5 shows the change in rate of extraction of visual letter information as a function of reading ability.

Table 5

Individual differences in lexical processing also appear at the word level. This can be shown in a variety of ways (Hunt, 1978; Hunt, Davidson, and Lansman, 1981). A particularly easy to understand illustration is the lexical decision task illustrated in Figure 3. The participant is shown either a word or non-word that follows the orthographic conventions of English; e.g. CARD or CARG. The task is to identify the stimulus as a word or a non-word. There is a correlation of -.4 between the time required for the word or non-word decision and psychometric measures of verbal ability (Hunt et al., 1981). The .4, incidentally, should not be interpreted as a

validity coeffecient. To do so would imply that we already have a perfect measure of "verbal ability," the present psychometric test. It is more correct to say that speed of lexical access does not explain all of verbal ability (and part of the point of this paper is that no one act does explain such a complex skill), but just as clearly it is a component that cannot be ignored.

Figure 3 here.

Lexical access does not occur in a single leap, word meanings are retrieved over time. Furthermore, the deeper the meaning required, the more the high verbal separates from the low verbal. An experiment by Goldberg, Schwartz, and Stewart (1977) shows this. They used the stimulus matching paradigm illustrated in Figure 4(a). Subjects were presented with two words, and asked if they were "the same" by various criteria. For example, the words in the pair (DEAR DEAR) are physically identical, the words in the pair (DEAR DEER) are homophones, and the words in the pair (DEER ELK) are members of the same semantic category. Figure 4(b) shows the times taken by "high" and "low" verbal university students to make each sort of identification. Students in the high verbal category were faster at making identifications in all cases. The disparity

between high verbal and low verbal students increased as the decision requirements became more complex.

Figure 4a,b

Lexical access requires visual or auditory "scanning", people seek out a target in the presence of irrelevant or conflicting stimuli. Scanning tasks are highly susceptible to *practice effects*, both for targets that are defined by their visual or auditory characteristics characteristics (Schneider and Shiffrin, 1977; Poltrock, Lansman, and Hunt, 1980) and their semantic characteristics (Fiske and Schneider, 1983). It is possible that some of the individual differences in lexical access are due to the fact that high verbal people simply deal with the language more, both in speech and reading. However, this is unlikely to be the only reason for the results. If high and low verbal students are given equivalent amounts of practice with an artificial lexicon, they still differ in their performance on the stimulus matching task (Jackson, 1980).

What do these findings imply for the total process of comprehension? Let us consider three facts about lexical processing in general:

1. Lexical processing is compulsory. You cannot comprehend language if you do not identify words.

2. Lexical processing draws relatively little attentional resources.

3. Individuals differ in the effeciency of their lexical processes.

These facts can be used to amplify upon the original model of comprehension. The modification is shown in Figure 5. Within an individual, the lexical processes are high priority, and require relatively little attentional resources. Therefore, in all but the most unusual situations lexical processes will be completed. On the other hand, there are substantial individual differences in the effectiveness of the completed process. Given the same amount of text, and the same time to study it, the high verbal individual probably has a better quality of word information to work with as further comprehension is attempted.

Figure 5 Here

SYNTACTICAL AND SEMANTIC PROCESSES.

Lexical processes deal with the meaning of individual words. Language comprehension requires an analysis of strings of words. From a formal linguistics point of view, the analysis of strings can be broken down into syntactical and semantic processes. Frederiksen (1982) uses the somewhat more general term "intratext processing." In contrast to lexical processing, some aspects of intratext processing are highly controlled, attention demanding activities. In particular, they compete for space in working memory. Furthermore, they show considerable individual differences.

The sentence verification paradgim provides a useful way to study isolated intratext processing. In sentence verification experiments the participant is asked to determine whether or not a sentence correctly describes a picture. A simple example is shown in Figure 6. The participant is first shown a picture, and then a sentence. The task is to decide whether the sentence correctly describes the picture. While it is possible to use visual imagery to solve some sentence verification tasks, it is also possible to arrange the situation so that people rely primarily on linguistic strategies. (Kroll and Corrigan, 1981; Mathews, Hunt, and MacLeod, 1980; MacLeod, Hunt, and Mathews, 1978). The remarks here are confined to studies in which it is reasonable to

assume that linguistic strategies were being used.

Figure 6 here.

Individuals differ a good deal in the speed with which they can perform sentence verification tasks. People with high verbal intelligence test scores tend to be consid-rably faster. This was first noted by Baddeley (1968), and has since been confirmed in numerous other studies (Hunt, 1978; Hunt, Davidson, and Lansman, 1981; Lansman, 1978; Lansman, Donaldson, Hunt, and Yantis, 1983). Perhaps most important, sentence verification contains a reliable component of prediction of general verbal ability over and above measures of lexical access (Hunt et al., 1981; Palmer, MacLeod, Hunt, and Davidson, Note 1). This is an important point, because it shows that individual differences in syntactical-semantic processes stand apart from individual differences in lexical access. Put another way, there are two abilities; the ability to get at words and the ability to extract meaning from groups of words. They are related, but they are not the same.

The distinction between individual differences in lexical and syntactic-semantic processing can be made in another way. Suppose that high school and college students took tests of

sentence verification and vocabulary. Scores on the two tasks would be positively correlated. However the two can be broken apart by a universal, naturally occurring phenomenon..age. Figure 7 summarizes data from two different experiments conducted in our laboratory, using two independent samples from the same population, University of Washington alumni who agreed to participate in a series of studies on changes in cognition over the working years. The left ordinate of Figure 7 shows vocabulary score as a function of age, in terms of the percentage of words correctly defined. We found, as have many others (Botwinick, 1977), that older people have vocabularies that are equal or better than those of their younger counterparts. On the other hand, the speed of analysis of what are, after all, very simple sentences slows markedly with advancing age.

Figure 7 here.

Why would syntactical and semantic processes be different from lexical processes? From the viewpoint of an experimental psychologist, multiword processes involve the application of highly overlearned rules to information that must be held in short term memory. Retrieving the rules is probably closely

akin to retrieving word meanings; an automated process that demands relatively little attention. Executing rules that involve the manipulation of information in working memory is a highly attention demanding process, that places considerable load on an individual's short term memory capabilities.

This point can be made by examining a particular type of intra-text processing; the resolution of anaphoric references. These are references in an utterance that can only be understood by identifying a general term with a specific instantiation introduced earlier. Pronouns are examples of anaphoric reference, as in

4a). John entered the restaurant. He was a tall and haughty man who had an appreciation for good food.

The second sentence makes sense only if "he" is identified as John. Example 4a is quite easy. Example 4b is harder, because of the increase in the material to be processed while holding information in memory:

4b). John entered the restaurant. The apple strudel looked particularly inviting. He was a tall and haughty man, who had an appreciation for good food.

Anaphoric referencing is still more difficult if there are

several possible candidates for the reference, as in

4c) John entered the restaurant. The headwaiter approached quickly. He was a tall and haughty man who had an appreciation for good food.

(Ehrlich, 1980). Clearly the resolution of anaphoric references requires holding information in memory while new information is analyzed. Is it possible to isolate such an ability and, if so, is it an important source of individual differences?

Daneman and Carpenter (1980) devised a procedure that measures the ability to hold information in memory while processing linguistic input. Note that this is what you must do in resolving anaphoric references. A participant reads simple sentences. On demand, the participant is required either (a) to state whether or not the sentence is true or (b) to recite the last words of the sentences preceeding the question sentence. A possible sequence of presentations is

5) When at last his eyes opened there was no gleam of triumph, no shade of anger.

The taxi turned up Michigan Avenue where they had a clear view of the lake.

RECALL

Subject responds- anger, lake.

"Memory span" measured in this way is not memory span in the usual sense, it is memory span in the presence of competing linguistic processing. Figure 8 shows the strong relation between memory span and the ability to resolve anaphoric references.

Figure 8.

Syntactical and semantic operations such as those just illustrated are needed to extract the precise meaning from a string of words. Imprecise meanings can be extracted, by reacting more globally to word meaning. Imagine comprehending the following sentences.

6a) Ivan the Terrible was cruel and despotic to his enemies.

6b) Ivan the Terrible was kind and loving to his

wife.

The semantics associated with the concept "Ivan the Terrible" implicitly deny the semantics associated with the phrase "kind and loving" in 6b. This is a loose sort of reasoning, for there is nothing literally wrong with 6b. (There is some historical evidence for its truth!) It is easy to demonstrate, though, that recognition of one word primes the mind to recognize related words. Most of the time this probably facilitates comprehension. But to what extent do people depend upon priming, not just to facilitate the controlled processing of sentences, but to guide it?

Individual susceptibility to word priming can be studied by examining sequential effects in the lexical decision task described earlier. Presentation of a word on trial n will facilitate the recognition of a related word on trial n+1. For instance presenting the word "Doctor" will speed recognition of the subsequent word "Nurse." The phenomenon has been replicated so often that it is beyond question. On other hand, individual differences in sensitivity to priming effects appear to be small and unreliable.

In one study in our laboratory (Palmer et al., 1980) we found substantial priming effects, averaged over subjects, but virtually no reliable individual differences. Naturally, this

precluded our finding any relation between individual sensitivity to priming and other aspects of verbal performance. An even stronger conclusion has been reached by Stanovich (1980), on the basis of a series of studies of priming by sentence context. In these studies a sentence fragment is presented, followed by a target word. The sentence can establish a context that facilitates word recogniton. An example is

7. CONTEXT Ivan the Terrible was
TARGET cruel

Stanovich observed that fluent readers do not benefit from context more than beginning readers. If anything, the converse is true. Some typical results are shown in Figure 9. In fact, in terms of percent improvement, less fluent readers profit more from a general context. The data displayed in Figure 9 are particularly interesting because in this study context was established by a spoken sentence (Perfetti and Goldman, and Hogaboam, 1979). Stanovich proposed a that weaker readers rely relatively more upon the *non-specific meanings reinforced* by priming, while strong readers rely more on the precise definition produced by efficient lexical and syntactical-semantic processing. Apparently his argument applies to verbal comprehension in general.

Figure 9.

One way to find out what people learned from hearing a phrase is to ask them to paraphrase it. When the phrase is unusual, there are strong individual differences in peoples' reactions to possible precise meanings, or to global meanings based on the words more or less in isolation. This was apparent in a study of paraphrase reported some years ago (Gleitman and Gleitman, 1979). Three groups of subjects; high school graduates not intending to go to college, college students, and Ph.D. candidates, listened to word strings, and then explained what they meant. The phrasings of the strings were created by taking a word triplet and altering it either in phrasing or order. To illustrate, most of us would agree that

8a) black bird-house

is a dark house for birds. Somewhat more startlingly,

8b) black-bird house

is a house, of undefined color, for a certain species of bird. Finally, 8c has a variety of interpretations; my own is "canary dipped in ink."

8c) black house-bird.

The Ph.D. candidates were able to give such interpretations. The high school graduates were less capable. The pattern of their errors displayed a systmatic bias toward conformity with the general context of the words..i.e. a distortion toward meaningful semantics by ignoring the precise order and phrasing of the linguistic stimulus. For instance, only members of the high school group were willing to interpret 8c. as a "black bird-house", a clear overriding of the linguistic stimulus.

Evidently the "high verbal" person simply has a more precise idea of what the linguistic stimulus is. There is an interesting way to test this contention; a way that may help to explain one of the facts of psychometric studies. Why is vocabulary such a good predictor of verbal ability?

Most words are learned by hearing them used in context, rather than by receiving explicit tuition (Miller, 1981). (The reader is invited to recall how he or she first learned to swear.) If the high verbal has a better idea of what the text says, then the high verbal person should be better able to infer what an unkown word must mean. They are, as shown by

three recent, and apparently independent, studies (Freyd and Baron, 1982; Van Darlen-Kapteijns and Elshout-Mohr, 1981; Sternberg and Powell, in press). Continuing a previous illustration consider the following constructed example.

9) The boyars hated Ivan because he had abrogated many ancient rights and privileges. The common people loved the tsar, both for his piety and because he had protected them against the harsh rule of the boyars.

What does the word "boyars" mean? Is it a singular or a plural term? How do you know?

In order to answer these questions a comprehender must extract the meaning of a word from the context in which it occurs. People with high verbal test scores, and older students, provide definitions from context that are more detailed, and more correct than those provided by low verbal students. Why? Because they have a more precise picture of the constraints placed on the unknown word, both by its own internal characteristics and by the context in which it occur.

The results of studies of intra-text processing indicate the need for a further expansion of the model. It is shown in Figure 10. Information from word sequences is normally extracted by effortful, controlled processing. Such processing

is relatively attention demanding. On the other hand, intra-word processing can be given a lower priority than lexical processing, because the intra-text processes operate on data in memory rather than on the stimulus as it is presented. The controlled intra-word processes operate in parallel with the non-specific, automatic, and relatively cost-free contextual priming effects. In normal communication the specific and non-specific processes produce complementary results. As we have shown, though, it is possible to produce (hard to comprehend) text in which they are opposed. When this is done there are strong individual differences in people's ability to react only to the more precise processes.

Figure 10

PRAGAMATICS

To state again, the purpose of communication is to let the comprehender know what is going on. The linguistic message, in the context that it is received, is used to build a representation inside the comprehender's head. Consider these fragments from a telephone conversation.

10) caller: Do you accept credit cards?

merchant: Yes, we take Master Charge, Visa, and American Express.

The merchant has, sensibly, responded to an implicit as well as an explicit question. (Thirty five of thirty nine merchants did this when asked (Clark, 1979).) In fact, this is a simplified version of the tight end's problem, as expressed earlier.

Three somewhat separate sources of individual differences in pragmatic processing can be distinguished. The first is simply individual differences in knowledge about the topic of the conversation. Not surprisingly, the extent to which people can deal with the pragmatics of a message depends in part upon the extent to which they understand the situation. Again sport provides a good illustration. Spilich et al. (1979) had people listen to a "broadcast" of a fictitious baseball game. They were then asked to recall the key events. Figure 11 shows the propositions recalled from the same broadcast by people who were "high" or "low" in baseball knowledge. The contrast is striking.

Figure 11.

This illustrates the not-too-surprising fact that people are better at comprehending a verbal message if they know a lot about the topic. In spite of the prosaicness of the finding, it is worth keeping in mind. The ability to comprehend a topic depends, in part, upon generalized verbal ability and in part upon specialized knowledge of the topic. (8).

Results such as those obtained with the baseball experts are usually explained by saying that people who are knowledgable in an area have highly overlearned schemas that they use in analyzing the incoming message. The schema directs the attention of the comprehender to the important aspects of the message. (The point applies to problem solving in general, not just about verbal comprehension (Chi, Glaser and Rees, 1982)). There is another, related source of individual differences. Language contains a number of "formulaic statements" that are used to indicate the pragmatic context of a communication. Perhaps the classic is "How are you today?", a question that normally does not elicit a medical report. There are considerably more subtle examples. Labov (1979) has made the point that individuals differ considerably in their use of formulaic statements, and that these differences are strongly a function of one's social group. At present the evidence for this assertion rests largely on linguistic examples. Formal research into the topic would be of

considerable interest.

The relation between knowledge and verbal comprehension poses a special challenge for educators. By definition, an educator communicates with people who are trying to acquire knowledge. Since learners will be busy acquiring and modifying their schemas of the subject matter being taught, it is important that they not be distracted by having to deal with difficult verbal constructions, analogies, or complex anaphoric referents. This statement is something more than advice to 'write clearly'. There is an excellent psychological reason for writing texts or presenting lectures at a level slightly below the audience's normal level of language complexity. When this is done the audience can devote most of their attention to the learning task.

Finally, individual differences do appear in pragmatic processing that depends solely on world knowledge that is available to everyone. Example 10a is a passage that, like most other passages, presents implicit and explicit information.

10a). Downstairs there are three rooms; the kitchen, the dining-room and the sitting-room. The sitting-room is in front of the house and the kitchen and the dining-room face onto the vegetable garden at the back of the house. The noise of the

traffic is very disturbing in the front rooms. Mother is in the kitchen cooking and Grandfather is reading the paper in the sitting-room. The children are at school and won't be home till tea-time.

Question 10b can be answered from information that is explicitly present in the text, while question 10c requires a simple inference.

10b) What is Mother doing? (cooking).

10c) Who is being disturbed by the traffic? (Grandfather).

Figure 12 shows the results of a study in which people answered both inferential and verbatim questions (Cohen, 1979). The subjects varied in education (advanced degrees vs. high school diploma or less) and age (20's vs. over 65). Very clearly there are striking effects of group membership. The effects are strongest on those questions that require inferencing. Cohen's results have been supported and amplified upon in subsequent research (Cohen 1981; Light, Zelinski, and Moore (1982)).

Figure 12 here

Why should such effects occur? Consider the amplified model presented in Figure 10. It shows that processing resources are distributed to the pragmatic processes at the very last, after everything else is done. This is a rational thing to do; for the pragmatic processes operate on a mixture of (partially) formed representations and of information retrieved from permanent memory. A failure of pragmatic inferencing could be due to simply running out of processing resources; either because the individual did not have enough in the first place or because the higher priority processes, being relatively less effecient in..say, a high educated vs. a low educated person..used so many resources that there was nothing left for pragmatic inference.

If it is true that pragmatic processing is a low priority, attention demanding process, then pragmatic processing should be the first process to deteriorate if attentional resources are reduced. The effect has been shown within an individual subject, by the simple expedient of giving people a minor sedative. Taylor (1982) repeated Cohen's paradigm, using healthy, well educated young subjects (Cohen's best performing group) who were tested either when sober or when given a medicinal dose of flurazepam (valium), a well known minor tranquilizer. Table 6 shows the results. As predicted,

pragmatic inferences were more sensitive to the drug than were verbatim reports. To gain some idea of the problem faced by Taylor's drugged subjects, think of how difficult it is to follow a story when you are tired.

The results of the studies showing parallel effects of age, education, and drug state have implications for educational practice, especially at the university 'adult education' level. Will the lecture that worked so well in the morning work as well in the evening? This is a subtle question. People do not suddenly run out of intellectual steam, either because they are over 30 (Cohen's 'old' subjects were in their 60's and 70's) or because they have had a couple of beers with dinner. There are also very marked individual differences in diurnal rhythms. The point is that one cannot take for granted the comprehension abilities of two different audiences, listening to the same message, at different times of the day. If an instructor finds that a message is not going through to an educationally prepared audience, some attention to the attentional demands of the message itself may be in order.

Table 6

CONCLUSIONS

Whatever happened to verbal ability? Verbal ability can be made to look like a dimension of the mind, and in one sense it is. It seems more profitable, though, to regard it as a collection of skills. The skills themselves are quite different from each other and they probably have different origins. It is obvious that verbal comprehension depends heavily upon culturally acquired knowledge of a language; knowledge of the lexicon and of the grammatical rules. It is not at all clear that skill in using the knowledge, once it has been acquired, is so tightly tied to cultural background. Inter-individual and intra-individual differences in the control of attention become important. When resource allocation places a limit on verbal comprehension the limit may be due either to a characteristic individual limit on resource utilization, a limit induced by the person's current physical state or a limit introduced by the demands of concurrent, non-verbal tasks. Imagine trying to listen to a physics lecture while riding a unicycle!

If the various verbal skills are so different, why do psychometric analyses so consistently uncover a single dimension of verbal ability? I believe that the reason is that total verbal performance is a highly interactive process; the performance of one component depends upon both the output of

other components and the extent to which there are enough processing resources for all. A specific example has already been given; vocabulary acquisition is facilitated by having a big vocabulary already, and by being able to process the text surrounding a known word. Numerous other examples could be given of how being better at one aspect of verbal processing facilitates being better at another. We comprehend until we have no more energy left. Those of us who can reach a surface comprehension quickly have the residual resources needed to examine the communication more deeply. The argument can be summed up by an anecodote. A husband and wife were discussing a book.

11) He: I'm not sure I know it.

She: The Fascinating Woman? I have shown you excerpts?

For the sake of the marriage, one hopes she had. But only the highly verbal husband would realize what she claimed to have done.

Notes

(1) This paper is a revision of an address presented to the A.E.R.A meetings, Montreal, Canada in April, 1983. Preparation of this paper was suppoted by the Office of Naval Research, Contract N00014-80-C-0631. The opinions expressed here are those of the author and do not represent the opinions or policies of the Office of Naval Research.

I am happy to acknowledge the constructive criticism of Dr. Susan Goldman on an earlier draft.

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Table 1

Test Name	Description
1. Reading comprehension	Answer questions about paragraph
2. Vocabulary	Choose synonyms for a word
3. Grammar	Identify correct and poor usage
4. Quantitative skills	Read word problems and decide whether problem can be solved
5. Mechanical reasoning	Examine a diagram and answer questions about it. Requires knowledge of physical and mechanical principles.
6. Spatial reasoning	Indicate how two dimensional figures will appear if they are folded through third dimensions

7. Mathematics achievement	A test of high school algebra

Description of some of the tests on the Washington Pre-College Test Battery

Table 2

	Factors		
Test	I	II	III
Reading comprehension	.79	.20	.09
Vocabulary	.75	.09	.34
Grammar	.71	.34	.04
Quantitative skills	.28	.65	.13
Mechanical Reasoning	.28	.38	.53
Spatial Reasoning	.00	.60	.40
Mathematics	.28	.65	.13

A factor structure for the tests in Table I. The structure was derived from Table 2. Factor I is clearly identified as a verbal ability factor. (The structure was derived using a principal factors solution followed by a varimax rotation.)

Table 3

Humanities	Social Sci.	Natural Sci.	Verbal Comp.
.42	.57	.28	1.00

Loadings of knowledge tests on verbal comprehension factor

Table 4

Skill	Correlation with Reading	Listening
Armor Crewman	.32	.29
Vehicle Repairman	.26	.38
Supply Clear	.40	.42
Cook	.34	.28

Correlations between job performance and verbal ability measures. Data from Stimbt, et. al. (1981).

Table 5

Reading Group	Letter identification rate (logistic transform)
11-47th percentile	364
48-77th percentile	378
85-97th percentile	406
98th percentile +	443

Letter identification and Reading Skill. Data from Frederikson (1982).

Table 6

Drug State	Verbatim	Inference
Valium, 10 mg.	6.53	5.81
Placebo	6.59	6.88

The mean number of questions answered as a function of type (verbatim vs. inferred information) and drug state. Data from Taylor (1982).

Figure Captions

1. Attentional resources distributed between comprehension processes. A primitive model.

2a. Procedure for studying dichotic listening.

2b. Results of discrimination of speech and non speech sounds.

3. The lexical decision task. Following a fixation signal (*) the observer sees either a word (card) or phonetically regular non-word (carg). The task is to indicate whether the string of letters is or is not an english word.

4a. The stimulus matching task. The participant is shown two words and asked if they are identical. Various criteria for identicality may be used.

4b. The time required to make stimulus identity judgements as a function of the criterion for identity and level of verbal ability.

5. A modified model of attentional resources. Resources are assigned first to lexical processing, but relatively few

resources are required. The remaining resources are allocated to syntactical, semantic, and pragmatic processes.

6. The sentence verification paradigm. An observer is first shown a sentence, then a picture. The task is to indicate whether or not the sentence correctly describes the picture.

7. Vocabulary and sentence verification scores as a function of age. Data from studies in our own laboratory.

8. Resolution of anaphoric references to words either 4-5 or 6-7 sentences before the anaphor. The percentage of correct resolutions is shown as a function of memory span while reading. Data from Daneman and Carpenter (1980).

9. Reaction times to name words as a function of priming ones. (none, list of words, story) and reading skill. Data from Perfetti, Goldman, and Hogaboam (1979).

10. A further expansion of the model. Attentional resources are assigned first to lexical processing, then, in progressively amounts, to syntactual-semantic and pragmatic processes.

11. Recall of facts about a fictitious baseball game, as a function of familiarity with the game.

12. Recall of explicitly presented and inferentially presented facts as a function of age and education. Data from Cohen (1981).

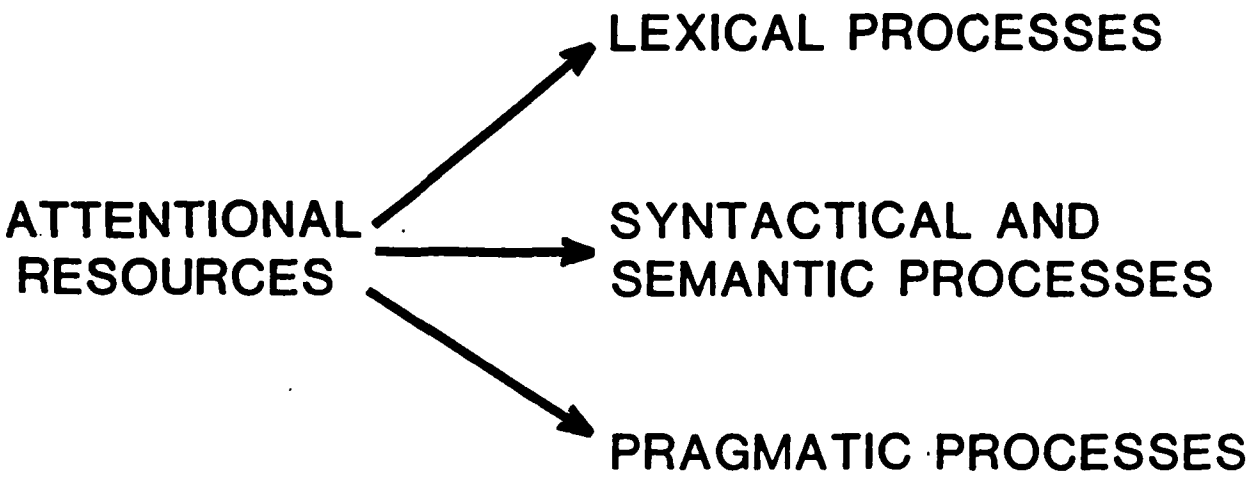

Figure 1

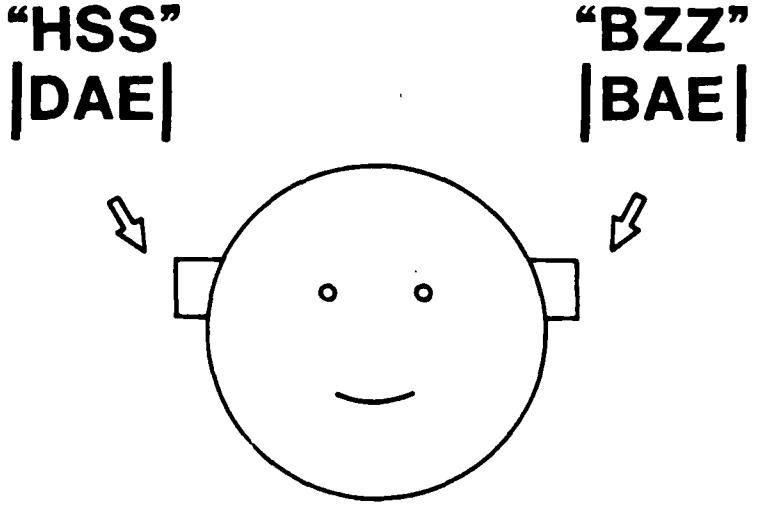

Figure 2a

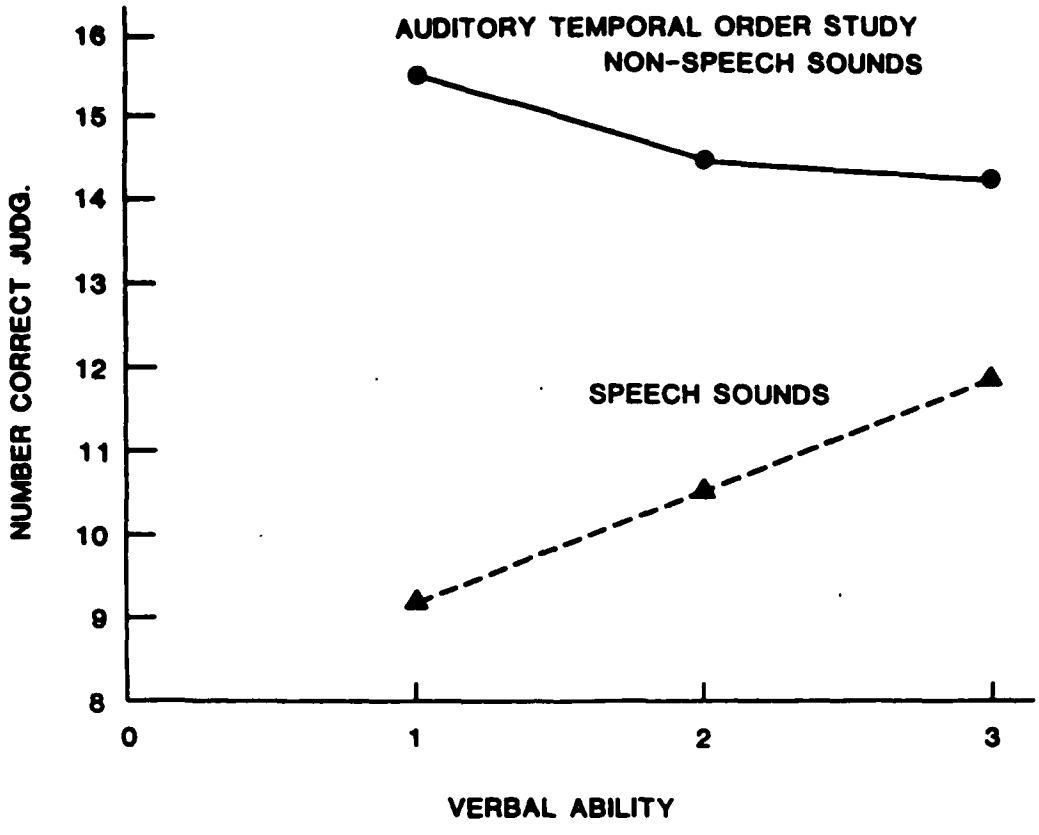

Figure 2b

*

CARD CARG

Figure 3

PHYSICAL IDENTITY	DEAR - DEAR
HOMOPHONE IDENTITY	DEAR - DEER
TAXONOMIC IDENTITY	DEER - ELK

Figure 4a

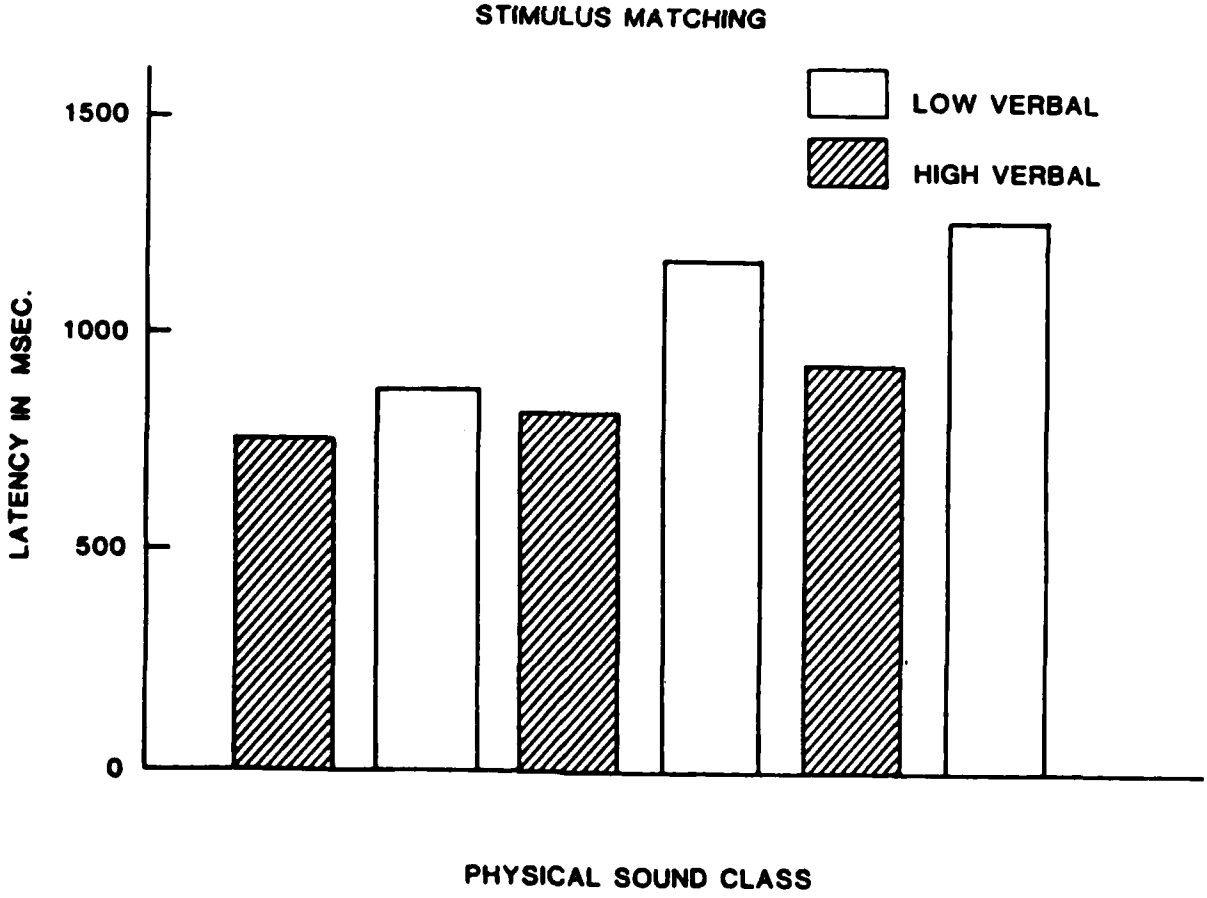

Figure 4b

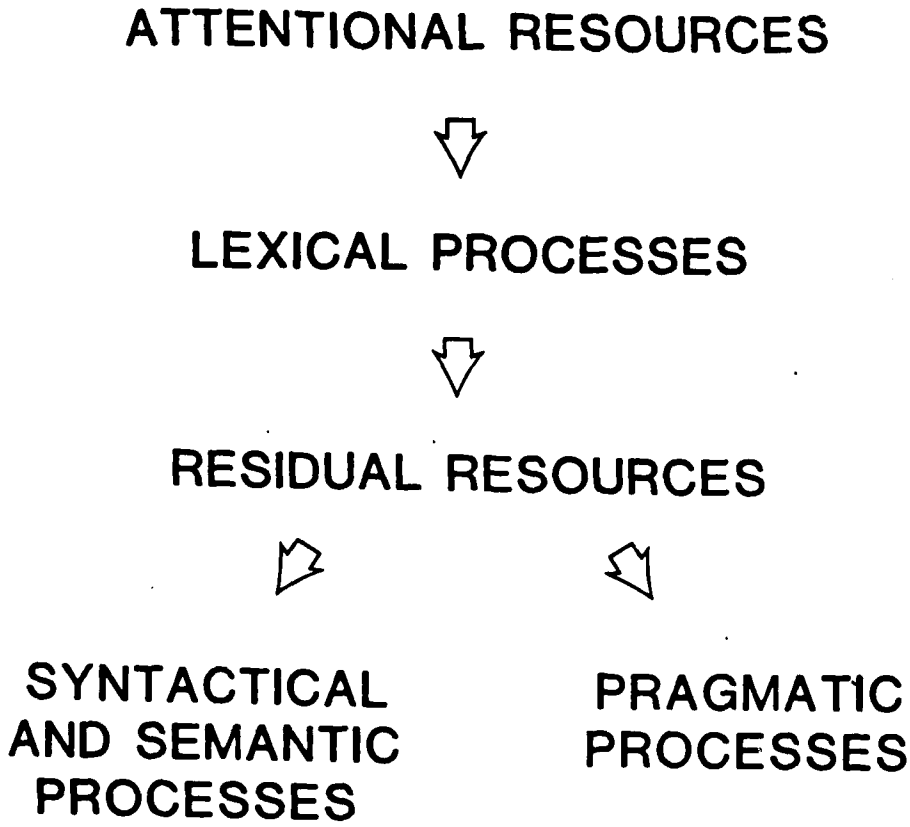

Figure 5

PLUS ABOVE STAR

+

*

Figure 6

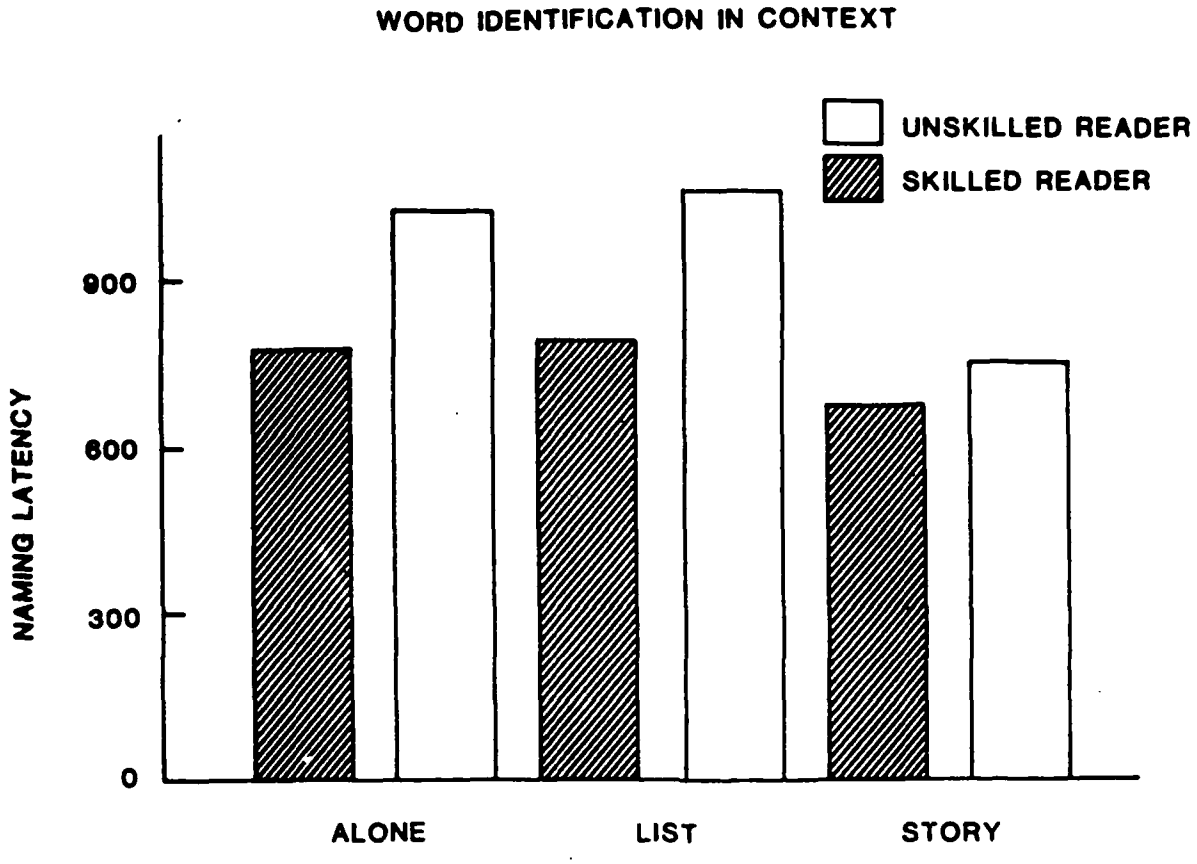

Figure 9

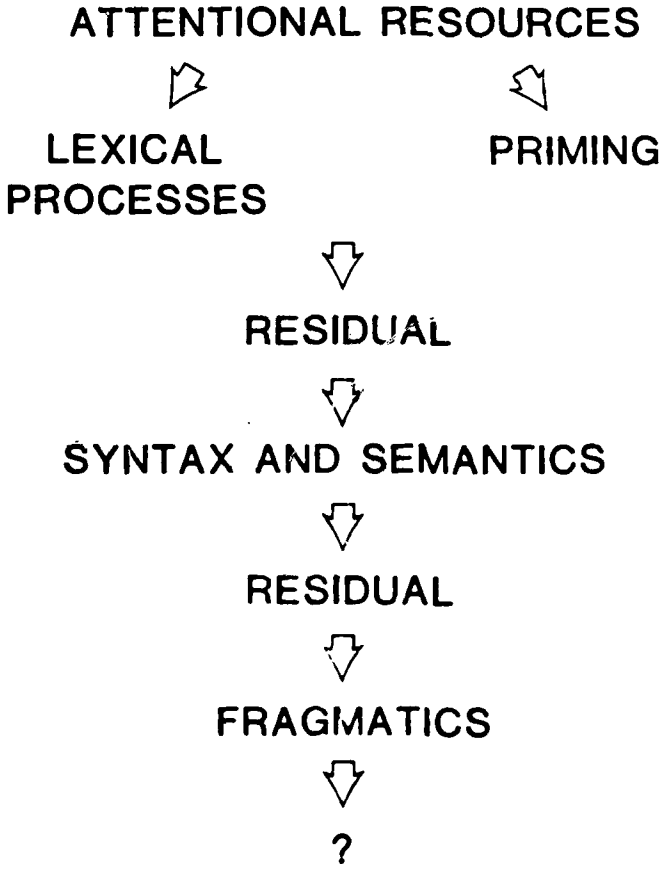

Figure 10

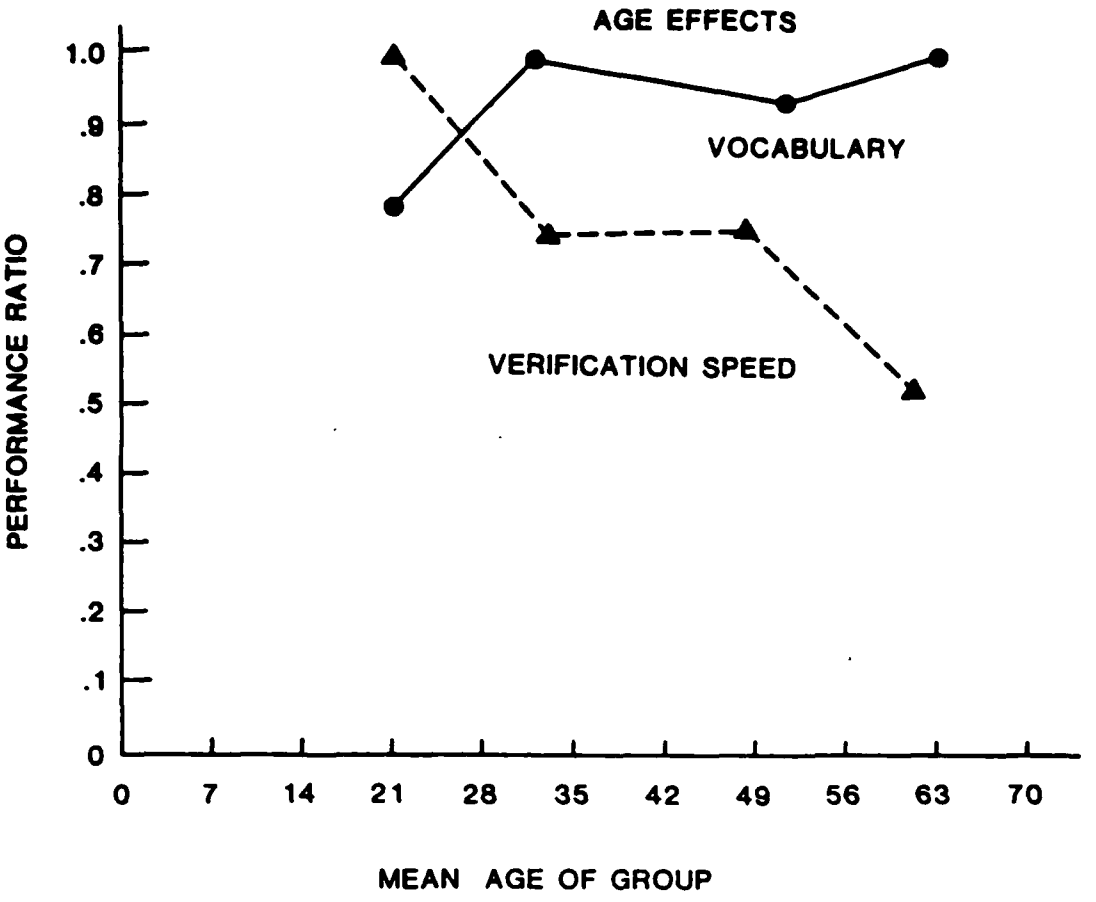

Figure 7

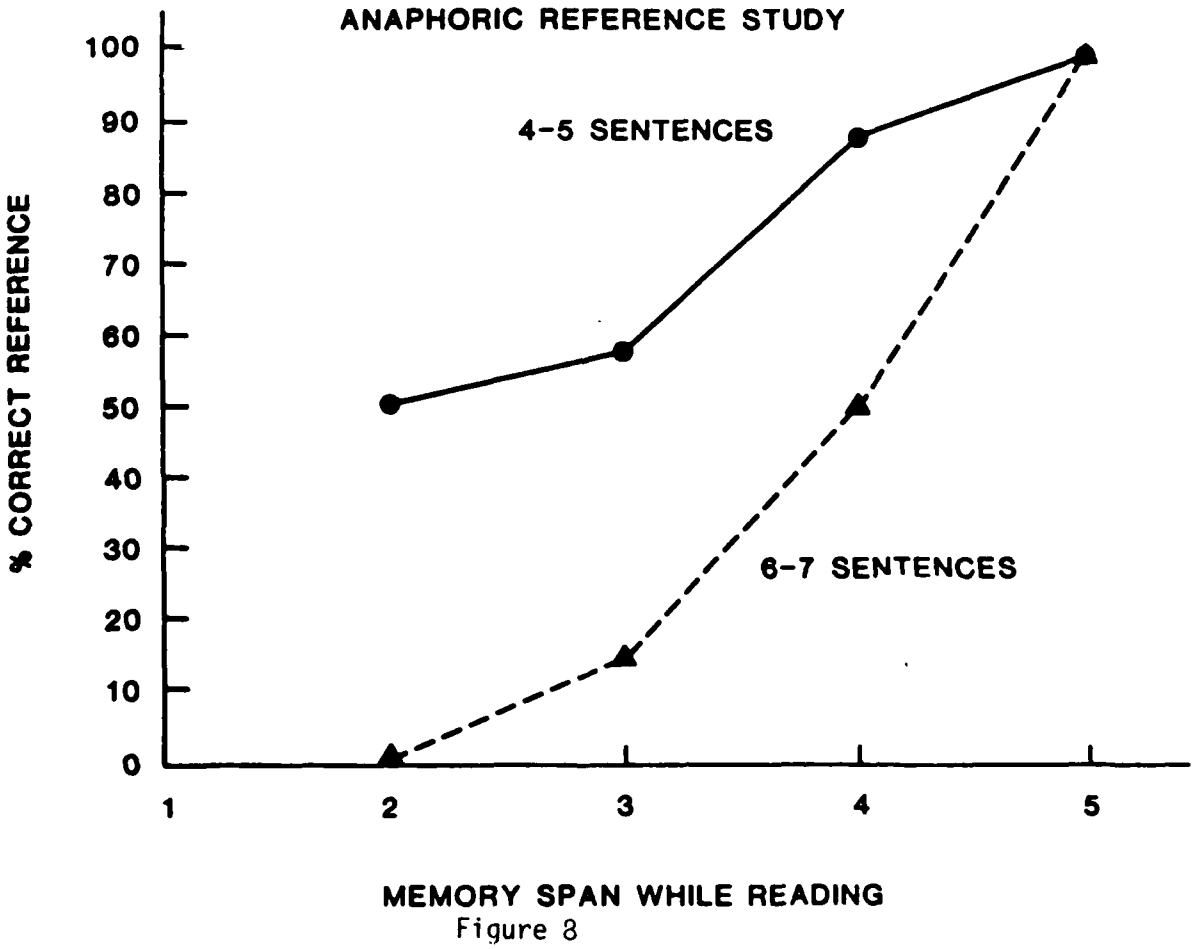

Figure 8

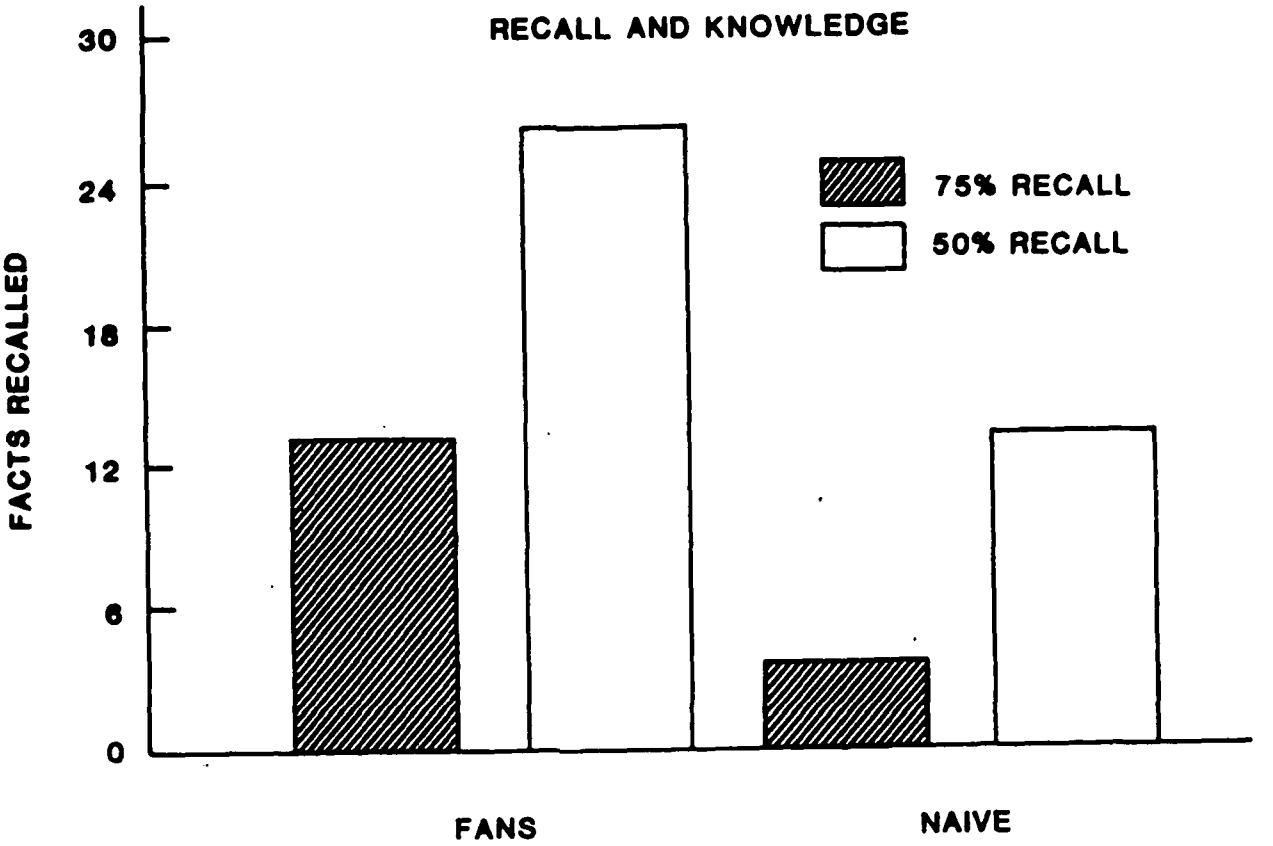

Figure 11

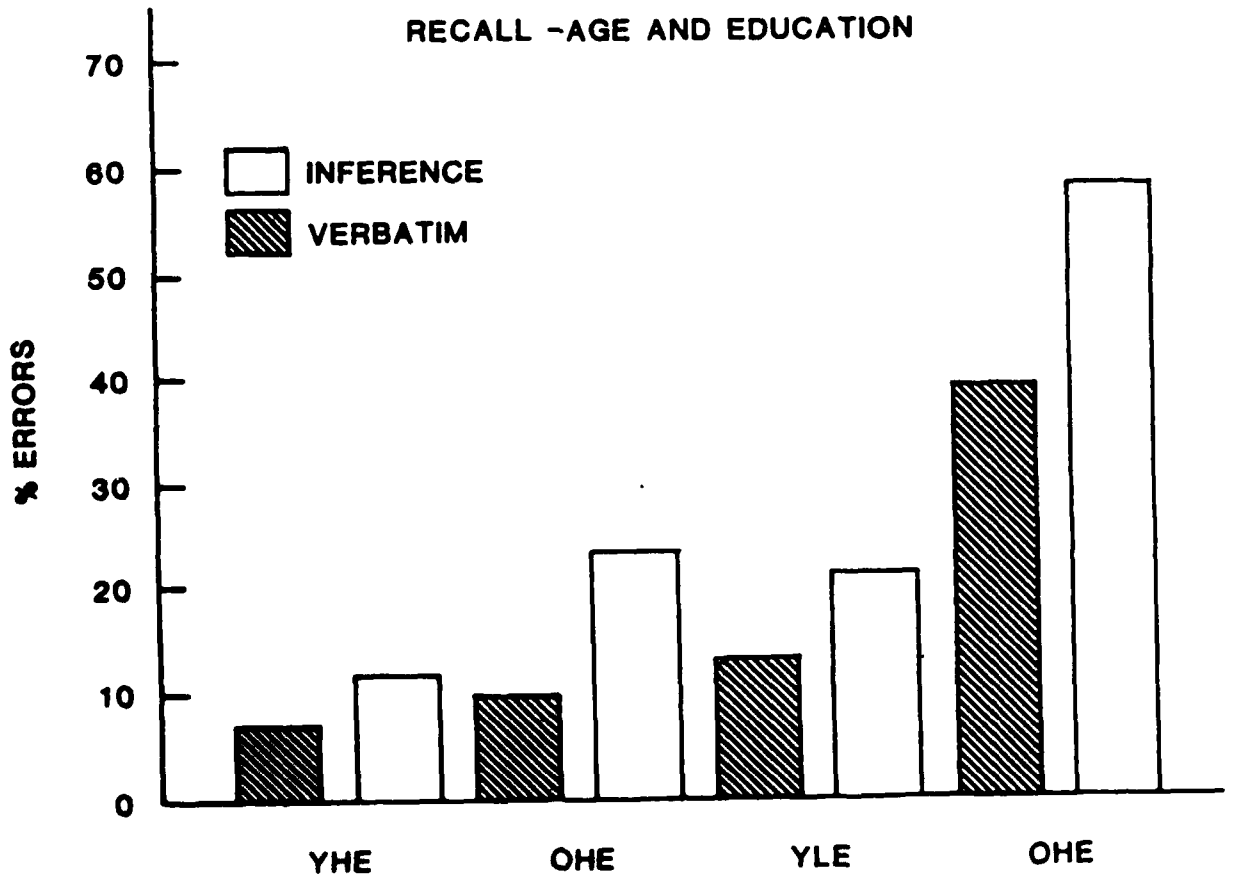

Figure 12

Washington/Hunt & Lansman (NR 150-457) 13-Sep-83

Navy

1	Aiken, Ed	
1	Baker, Meryl S.	3 5
1	Bond, Nicholas A.	12345
1	Bory, Alexander (NAMRL)	
1	Collyer, Stan	12345
1	CURRAN MIKE	12345
1	Duffy, Tom	2345
1	Federico, Pat-Anthony	0 2345
1	HOLLAN JIM	2345
1	Hutchins, Ed	345
1	KERR NORMAN J	12345
1	Kincaid, Peter	345
1	MALOY WILLIAM L	12345
1	McLachlan, Joe	3
1	Montague, William	0 2345
1	NPRDC TECHNICAL DIRECTOR	12345
6	NRL CODE 2627	12345
1	ONR 433	345
1	ONR 441NP	2 45
6	ONR 442PT	12345
1	OP115	12345
1	Petho, Frank C.	012 45
1	Rimland, Bernie	012 5
1	Smith, Robert G.	012345
1	SMODE ALFRED F	2345
1	SORENSEN RICHARD	12345
1	Steinheiser, Frederick	0 345
1	Thomson, Gary	0 2 5
1	Wetzel, Douglas (NPRDC)	012 45
1	Wulfeck, Wally	3

Marine Corps

1	GREENUP H WILLIAM (MCDEC)	12345
1	ONR 100M	12345
1	SLAFKOSKY AL	12345

Washington/Hunt & Lansman (NR 150-457) 13-Sep-83

Army

1	FARR BEATRICE	2345
1	Narva, Marshall	0 45
1	O'Neil, Harry	345
1	Orasanu, Judith	345
1	Psotka, Joseph	345
1	SASMOR ROBERT	12345
1	WISHER ROBERT	12345

Air Force

1	AFOSR Life Sciences	12345
1	Alluisi, Earl	12345
1	Christal, Raymond E.	012345
1	DALLMAN, BRYAN	3 5
1	Fregly, Alfred	012345
1	HADDAD GENEVIEVE	2345
1	Tangney, John	1234
1	Yasatuke, Joe	2345

Washington/Hunt & Lansman (NR 150-457) 13-Sep-83

Department of Defense

12	DTIC	12345
1	Grafman, Jordan (Walt Reed)	
1	OUSDRE	12345
1	Thorpe, Jack A.	345

Civilian Agencies

1	Butler, Patricia A.	0 2345
1	CHAPIN PAUL	5
1	CHIPMAN SUSAN	2345
1	Esty, Edward	34
1	Fuentes, Edward J.	3
1	Gilmer, Gloria	34
1	Klein, Sue	3
1	MELMED ARTHUR	
1	Molnar, Andrew R.	0 2345
1	Selden, Ramsay	
1	USCG PSYCHOLOGICAL RESEARCH	12345
1	WITHROW FRANK	2345
1	Young, Joseph L.	012345

Washington/Hunt & Lansman (NR 150-457) 13-Sep-83

Private Sector

1	Anderson, John R.	2345
1	Baddeley, Alan	2345
1	Baggett, Patricia	2345
1	Bejar, Isaac	12 5
1	BLACK, JOHN	1 345
1	Bryan, Glenn	1234
1	CARBONELL, JAIME	345
1	CARPENTER PAT	2 45
1	Carroll, John B.	0 2 5
1	CHASE WILLIAM	2 45
1	CHI MICHELINE	45
1	Clancey, William	0 345
1	COLE, MICHAEL	
1	COLLINS ALLAN M	345
1	COOPER LYNN A	2 45
1	ERIC	12345
1	Feurzeig, Wallace	0 345
1	Fletcher, Dexter	12345
1	FREDERIKSEN JOHN R	12345
1	Gentner, Don	2 4
1	Gentner, Dedre	34
1	Glaser, Robert	012345
1	Hock, Marvin D.	0 2345
1	GOGUEN, JOSEPH	2 45
1	Gopher, Daniel	2 45
1	Green, Bert	012345
1	GREENO JAMES G	12345
1	Hayes-Roth, Barbara	2345
1	Human Intelligence Newslett	0 2345
1	HUMPHREYS LLOYD	12 5
1	Just, Marcel	2 4
1	KELSO, SCOTT	12345
1	KIERAS DAVID	2345
1	KINTSCH WALTER	45
1	Kosslyn, Stephen	012 45
1	Langley, Patrick	345
1	Lansman, Marcy	0 2 5
1	LARKIN JILL	2345
1	Lesgold, Alan	012345
1	LEVIN, JIM	345
1	LEVINE MICHAEL	12345
1	LEWIS CHARLES	12345
1	LINN ROBERT	12 5
1	Lyon, Don	1234
1	McClelland, Jay	2 45
1	MUNRO ALLEN	2345
1	Norman, Donald A.	0 2345
1	Orlansky, Jesse	012345
1	PAULSON JAMES A	12345
1	PELLEGRINO JAMES	2 45
1	PENNINGTON, NANCY	345
1	POLSON PETER	2345
1	POSNER MIKE	2 45
1	Reif, Fred	0 2345
1	RESNICK LAUREN	2345

Private Sector

1	ROSE ANDREW M	12345
1	Rothkopf, Ernst	012345
1	Rouse, William	345
1	RUMELHART DAVID	5
1	Samet, Michael	345
1	Schneider, Walter	0 2345
1	Schoenfeld, Alan	0 2345
1	SMITH EDWARD	2 45
1	SNOW RICHARD	12345
1	Spoehr, Kathryn T.	2345
1	Sternberg, Robert	0 2345
1	Tatsuoka, Kikumi	012345
1	Tatsuoka, Maurice	1 34
1	Thorndyke, Perry	0 345
1	Towne, Doug	0 345
1	Van Lehn, Kurt	345
1	Weiss, David J.	012 5
1	Wescourt, Keith T.	0 345
1	Whitten, William B.	0 2345
1	Wickens, Christopher	0 2 45
1	Wickens, Tom	4
1	WILLIAMS, MIKE	345